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NIXON & VANDERHYE, PC
901 NORTH GLEBE ROAD, 11TH FLOOR
ARLINGTON, VA 22203

EXAMINER	
SONG, MATTHEW J	

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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

MAILED

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GROUP 1700

Application Number: 09/936,818
Filing Date: February 28, 2002
Appellant(s): TAKAHASHI ET AL.

Joseph A. Rhoa
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 3/1/2007 appealing from the Office action mailed 1/23/2006.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,956,364	Jiang et al.	9-1999
6,358,822	Tomomura	3-2002
WO 98/44539 A1	Tomomura	08-1998

- Ito, "Empirical Interatomic Potentials for Nitride Compound Semiconductors", Jpn. J. Appl. Phys. Vol 37 (1998) pp L574-L576.

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

1. Claims 29, 32-33, 38-39, 42-50 and 53-62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jiang et al (US 5,956,364) in view of Tomomura (WO 98/44539), where US 6,358,822 is used as an accurate translation.

In a method of making a semiconductor device, note entire reference, Jiang et al teaches molecular beam epitaxy is used to make required multiple layers of material layers, such as indium gallium arsenide aluminum nitride (col 3, ln 1-40), this reads on applicant's III-V compound semiconductor including, as a V group components, nitrogen and at last one of arsenic (As), phosphorous (P), and antimony (Sb).

Jiang et al does not teach supplying aluminum and ammonium to a surface so as to obtain a mixed crystal with a composition comprising nitrogen and wherein the substrate temperature is 450-640°C.

In a method of forming a mixed crystal of III-V compound semiconductor, note entire reference, Tomomura teaches a Group III-V compound semiconductor layer including nitrogen and at least another Group V element grown by molecular beam epitaxy and is grown by irradiating a substrate with material molecular beams in crystal growth chamber so evacuated that the mean free path of material molecules is larger than the distance between the substrate and molecular beam sources, a nitrogen compound is used as a nitrogen source and molecules of the nitrogen compound decompose after they reach the substrate surface and only nitrogen atoms

are incorporation into the growing semiconductor crystal (abstract). Tomomura also teaches a nitrogen hydride, NH_3, is used as the nitrogen compound and the substrate temperature is maintained at 500-750°C during crystal growth ('822 col 3, ln 1-50). Tomomura also teaches the substrate is a compound semiconductor which as a zinc blend structure and the substrate surface has an off-angle of 5-15° from {100} plane to a {111}A plane and decomposition is promoted and high incorporation efficiency of nitrogen is achieved on this substrate surface ('822 col 3, ln 50 to col 4, ln 5). Tomomura also teaches Al, Ga and In molecular beams were directed to a substrate by heating a solid metallic material using a Knudsen cell ('822 col 5, ln 10-55). Tomomura also teaches incorporation efficiency of nitrogen into the crystal can be improved ('822 col 4, ln 5-35). Tomomura also teaches GSMBE, CBE and MOMBE ('822 col 15, ln 1-30 and col 1, ln 5-55). Tomomura also teaches a timing chart for supplying reactant gases in sequence and one cycle of the source supply sequence is set in a range of 0.5 to 5 molecular layers to form a mixed crystal with uniform composition ('822 Fig 6 and col 10, ln 25-67). Tomomura also teaches the method can be used for mixed crystals of a II-v compound semiconductor, which includes nitrogen, at least one other the Group V elements As, P, Sb and Bi, and at least one of the Group III elements B, Al, Ga, In, and Tl (col 15, ln 1-31).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Jiang et al with Tomomura method of forming Group III-V compound semiconductor with ammonium at a temperature of 500-750°C using MBE to improve incorporation efficiency of nitrogen into a crystal (col 3, ln 25-35 and col 4, ln 1-20). Overlapping ranges are held to be obvious (MPEP 2144.05).

The combination of Jiang et al and Tomomura does not teach the crystallization of the nitrogen from the ammonium which is supplied to the surface of the crystal into the surface of the crystal is accelerated by the aluminum supplied to the surface of the crystal. However, this feature is inherent because the combination of Jiang et al and Tomomura teaches supplying NH_3 and aluminum to the surface of a crystal, as applicant; therefore the claimed effect of supplying the NH_3 and aluminum to the surface would be inherent because the combination of Jiang et al and Tomomura teaches a similar process.

Referring to claim 32, the combination of Jiang et al and Tomomura does not explicitly teach a nitrogen composition is controlled based on an amount or composition ratio of added aluminum. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Jiang et al and Tomomura by controlling a nitrogen composition based on a composition of aluminum to obtain an epitaxial layer with a desired stoichiometry. Changes in composition are held to be obvious (MPEP 2144.05).

Referring to claim 38-39, Tomomura teaches the substrate surface has an off-angle of 5-15° from {100} plane to a {111}A plane, this reads on applicant's surface slanted from a (100) surface in a [011] direction or a crystal face which is equivalent.

Referring to claim 42, Tomomura teaches an evacuated chamber and a mean free path of a molecule of each source material is longer than a distance between the substrate and a source material ('822 col 2, ln 50-67).

Referring to claim 43, Tomomura teaches solid sources in Knudsen cells.

Referring to claim 44, Tomomura teaches a nitrogen compound decomposed at the growth surface ('822 col 3, ln 1-10)

Referring to claims 45-46, Jiang et al teaches a GaAs, Si or InP or the like substrate (col 3, ln 1-15).

Referring to claim 47-48, Jiang et al teaches a epitaxial deposition to produce a multitude of layers that comprise a complete vertical cavity surface emitting laser (VCSEL) (col 3, ln 1-25), this reads on applicant's semiconductor device.

Referring to claim 53-54, the combination of Jiang et al and Tomomura teachesusing in a single mode laser application, or as a random phase mask fro use in multi-mode laser application (Abstract), this reads on applicant's apparatus which uses the semiconductor device.

2. Claims 40-41 and 51-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jiang et al (US 5,956,364) in view of Tomomura (WO 98/44539), where US 6,358,822 is used as an accurate translation, as applied to claims 29, 32-33, 38-39, 42-50 and 53-62 above, and further in view of Ito (Empirical interatomic potentials for nitride compounds semiconductors).

The combination of Jiang et al and Tomomura teaches all of the limitations of claim 40, as discussed previously, the semiconductor layer A including at least aluminum and nitrogen in it composition but not including indium in its composition and the semiconductor layer B including at least indium in its composition but not including nitrogen in its composition.

Ito teaches versatility of empirical potentials with AlN for various monolayer superlattices with InP or InAs (Abstract and L575). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Jiang et al and Tomomura with Ito superlattice of AlN and InP or InAs monolayers because superlattices reduce lattice mismatch strain between layers.

(10) Response to Argument

Appellant's primary argument is that the prior art does not teach the claimed effect of having crystallization of nitrogen from the ammonium which is supplied to the surface of the crystal is accelerated by the aluminum supplied to the crystal surface. However, it is the Examiner's position that the prior art clearly teaches supplying ammonium and aluminum gases to a substrate to form a Group III-V compound, thus the claimed effect of accelerated nitrogen crystallization is an expected effect. The fact that appellant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). Appellant also makes several arguments regarding that using temperatures from 450-640°C during MBE is surprisingly beneficial when supplying NH_3 and Al at the same time in that the crystallization is accelerated. However, supplying NH_3 and Al at the same time is currently not claimed. Also, the temperature ranges is within the range typically used when NH_3 is a precursor and the prior art explicitly recognizes that temperature is a result effective variable.

Claim 29 arguments:

Appellant's argument that Tomomura does not disclose using such temperature when forming a layer of Al via MBE is noted but is not found persuasive (See page 13 of the Appeal Brief). Appellant alleges that Tomomura does not teach using a temperature of 450-640°C during MBE when supplying NH_3 and Al at the same time so that crystallization of the nitrogen from the ammonium is accelerated by the Al in this temperature range. First, Tomomura teaches using

a substrate temperature in a range of 500-750°C can be used when NH_3 is used as the nitrogen source, and explicitly teaches using 580°C (See column 7, lines 30-41). Second, Tomomura teaches forming a III-V compound semiconductor using ammonia while the substrate is maintained at 500-750°C and the Group III elements includes Al (See column 15, lines 18-65). The Tomomura patent thus clearly suggests the use of NH_3 and Al to form a III-V compound semiconductor at a temperature claimed by appellant.

In regards to the limitation, " so that crystallization fo the nitrogen from the ammonium is accelerated by the Al", Tomomura teaches using NH_3 and Al within the claimed temperature range thus the effect is expected to be the same because the prior art teaches using the same reactants at the same temperatures used by appellant. Appellant teaches that it is possible to crystallize nitrogen into a mixed crystal at a temperature of 450°C or more (See page 37, lines 1-15 of the specification). Thus the entire range of temperatures taught by Tomomura is capable of accelerating nitrogen crystallization. The upper range of 640°C does not reflect a decrease in cracking efficiency. The upper limit of 640°C is merely to prevent a nitride phase of AlGaN (See page 37, lines 9-15 of the specification).

In response to appellant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which appellant relies (i.e., when supplying NH_3 and Al at the same time (see page 13 of the appeal brief)) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). Appellant alleges that there are unexpected results when a temperature of 450-640°C is used while NH_3 and Al are supplied simultaneously. However, the

instantly claimed invention does not require supplying NH_3 and Al simultaneously. Therefore, appellant's alleged unexpected results are not in the same scope as the claimed invention.

Appellant's argument that the temperature range of 450-640°C is critical is noted but not found persuasive (See page 11-12 of the appeal brief). Appellant alleges that it is possible to crystallize nitrogen into a mixed crystal in a more efficient manner at temperature of 450°C or more and substrate temperature of 680°C are problematic because a nitride phase of AlGaN may be formed. First, Tomomura teaches the substrate temperature is in a range of 500-750°C when NH_3 is used as a precursor and specifically a substrate temperature of 580°C (see column 7, lines 30-35 and column 3, lines 32-40); therefore the use of 580°C is clearly suggest by Tomomura. Second, Tomomura teaches if the substrate temperature becomes lower than 500°C, the decomposition efficiency of NH_3 at the growth surface decreases and if the substrate temperature exceeds 750°C, desorption of Group V elements increases, which increases defects in the mixed crystal. Clearly, Tomomura recognizes that substrate temperature is a result effective variable, thus it would have been obvious to one of ordinary skill in the art to optimize temperature. Finally, appellant's claimed temperature range is not critical. It is noted that the appellant's specification teaches an upper limit of 680°C, while appellant's claimed invention only has an upper limit of 640°C. Also, appellant's teaches that it is possible to crystallize nitrogen into a mixed crystal at a temperature of 450°C or more (See page 37, lines 1-15 of the specification). Thus the entire range of temperatures (500-750°C) taught by Tomomura is capable of accelerating nitrogen crystallization. The upper range of 640°C is not related to the in cracking efficiency or nitrogen crystallization rate. The upper limit of 640°C is merely to prevent a nitride phase of AlGaN (See page 37, lines 9-15 of the specification). The use of a nitrogen precursor

and high temperatures is known in the art to nitride a surface, thus the use of lower temperature to prevent nitriding is within the ordinary skill of a person in the art.

Appellant's argument that the prior art does not teach that Al and ammonium are supplied simultaneously is noted but not found persuasive. (See page 14 of the appeal brief). Appellant alleges that Tomomura merely in Al in a laundry list of Group III elements and does not suggest supplying ammonia and Al simultaneously. First, it is noted that the features upon which appellant relies (i.e., Al and ammonia are supplied simultaneously) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). Second, Tomomura clearly suggests the use of Al in conjunction with the use of ammonia, as evidenced by Tomomura's claims 1-4 and column 15, lines 15-35, which teaches forming a III-V compound using ammonia and Al as one of the Group III elements. Finally, even if the claim did require simultaneously supplying Al and ammonia, this feature would have been suggested by Tomomura. Tomomura teaches forming a mixed crystal of III-V where Ga and In are supplied simultaneously with NH_3 (See Figure 6 and Abstract). While Tomomura teaches Ga and In in Figure 6, this would clearly suggest the use of another Group III element, such as Al, with a similar timing and simultaneously with NH_3 to form a mixed crystal layer.

In response to appellant's argument that the examiner's conclusion of obviousness is based upon improper hindsight reasoning, it must be recognized that any judgment on obviousness is in a sense necessarily a reconstruction based upon hindsight reasoning. But so long as it takes into account only knowledge which was within the level of ordinary skill at the

time the claimed invention was made, and does not include knowledge gleaned only from the applicant's disclosure, such a reconstruction is proper. See *In re McLaughlin*, 443 F.2d 1392, 170 USPQ 209 (CCPA 1971).

Claim 32 arguments:

Appellant's argument that the prior art does not teach a nitrogen composition is controlled based on an amount or composition ratio of added aluminum is noted but not found persuasive. (See page 14 of the appeal brief). The Examiner admits that the prior art does not explicitly teach controlling the nitrogen composition based on the amount of aluminum. Tomomura teaches optimizing the conditions of each molecular beam to obtain a layer with a desired nitrogen concentration. (See column 12, lines 50-65). It is the Examiner's position that changes in stoichiometry to obtain an epitaxial layer with a desired stoichiometry are within the skill of an ordinary person in the art and the adjustment of precursor ratios is expected to change amount incorporated into a crystalline layer.

Claim 32 arguments:

Appellant's argument that the prior art does not teach aluminum is crystallized in a restricted region, whereby only in the restricted region nitrogen is crystallized is noted but not found persuasive (See page 15 of the appeal brief). Tomomura teaches deposition on a substrate which is controlled to a particular temperature effective for deposition (See column 3, line 60 to column 4, line 5 and column 5, lines 50-60). The deposition on the substrate clearly suggests appellant's crystallized in a restricted region because deposition does not occur in other regions of the reactor but is limited to the substrate.

Claim 40, 41, 51, and 52 arguments:

Appellant's does not set forth any additional arguments. Claims 40, 41, 51, and 52 stand rejected based on the arguments set forth in regards to claim 29.

Conclusion

Appellant has based many of the arguments on a key feature, which is not presently claimed. Appellant alleges that the prior art does not teach supplying Al and NH_3 **simultaneously** at the claimed temperature. However, the claimed invention does not require supplying Al and NH_3 **simultaneously**. Appellant also alleges that prior art does not teach the claimed temperature range of 450-640°C, which is allegedly critical. However, Tomomura clearly teaches using a temperature of 500-750°C when using NH_3 as a precursor, and the range taught by Tomomura overlaps the claimed range. Appellant's allege that use of Al and NH_3 together results in increase crystallization. However, the fact that appellant has recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). The use of NH_3 and Al in an MBE process is conventionally known to be use to form AlN based compounds, thus the advantage recognized by appellant would naturally flow from the suggestion of the prior art.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

Matthew Song

DUANE SMITH
SUPERVISORY PATENT EXAMINER

Conferees:

Duane Smith

Jennifer K[redacted]-Michener

JENNIFER MICHENER
QUALITY ASSURANCE SPECIALIST